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Bryophyte flora of the Sierras de Filabres, Cabrera, Alhamilla and Cabo de Gata (Almería, S.E. Spain)

P. GARCÍA-ZAMORA, R. M. ROS and J. GUERRA

University of Murcia, Spain

Summary

The bryophyte flora of the Sierras de Filabres, Cabrera, Alhamilla and Cabo de Gata of Almería province (S.E. Spain) includes 280 taxa (236 mosses and 44 liverworts) of which 74 are new to the province of Almería, 31 to the southeastern part of the Iberian Peninsula and 4 to the Iberian Peninsula. Data about their biogeography and ecology are given.

KEYWORDS: Bryophyte flora, Almería, S.E. Spain, Mediterranean, aridity.

Introduction

This floristic catalogue includes bryophyte taxa collected in the study areas from 1990 to 1995 and those quoted in the bibliography of the province of Almería, S.E. Spain. This catalogue adds to records made in the provinces of Murcia (Ros & Guerra, 1987a) and Alicante (Cano, Ros & Guerra, 1996c), enlarging our knowledge about the bryoflora of the Spanish south east. The province of Almería borders on the provinces of Murcia and Granada to the North, and its coast is bathed by the Mediterranean sea to the south and east. The four mountain ranges (sierras) studied are (north to south): Sierra de los Filabres, Cabrera, Alhamilla and Cabo de Gata (Fig. 1).

From the geological point of view, the province of Almería is situated in the western and southwestern end of the Betic range, comprising materials belonging to the south-Bética and Bética in the strict sense, apart from neogen-quaternary post-orogenic sediments that fill huge sloping depressions and large outcrops of igneous rocks laid down during a period of post-orogenic volcanic activity. Thus, in Filabres graphitic micaschists, quarzites, micacites, amphibolites, marbles and gneiss are mainly found, and in Alhamilla and Cabrera, miscaschists, quarzites and philites occur together with lime and dolomites. These substrata, except for the micaschists that disintegrate easily, allow the establishment of generally acidophilous bryophyte communities. The lithological base of the Sierra del Cabo de Gata is composed of traquite and andesite rocks that do not allow easy colonisation by bryophytes due to their hardness. Despite this lithological variety, and because of the great aridity, many soils formed on siliceous rocks are clearly basic, and others become strongly salinized. Nevertheless, significant erosion ensures that the dominant soils are regosols, due to their poor differentiation into horizons (Ríos, 1983).

The uneven distribution and low rainfall in Almería typify the province as desert-like. The average annual rainfall is 355 mm, and everywhere higher than 200 mm,

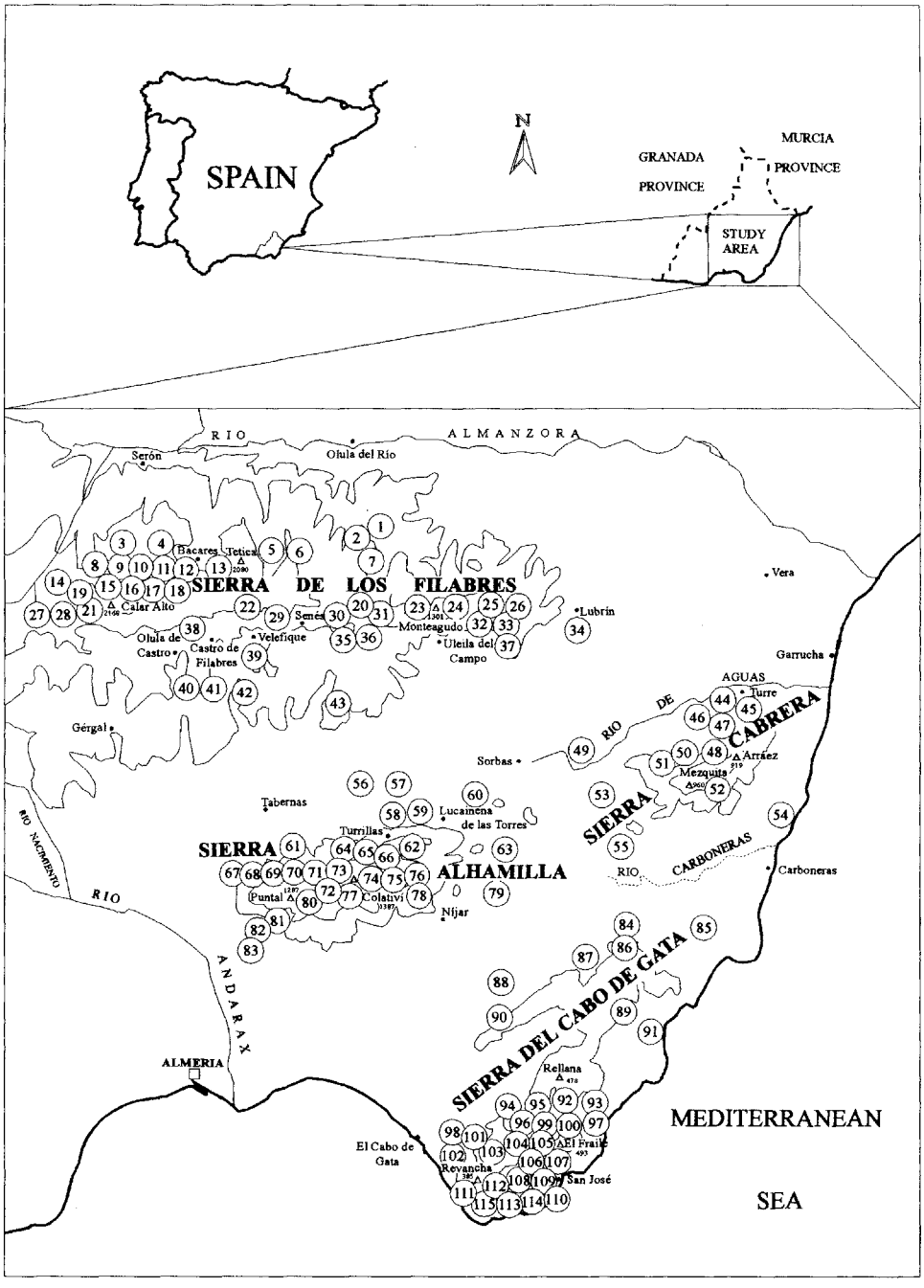

Figure 1. Geographic location and studied sites.

except for the lowest points such as Cabo de Gata and the Almanzora river. It is therefore considered the driest and most arid Spanish province. The conditions of the coast and nearly the whole of the eastern part are similar to those of parts of North Africa and the Near East. The scarcity of rainfall is exacerbated by its annual and seasonal irregularity, and by its torrential character, together with a potential water deficit which is the highest in the Iberian Peninsula. Almería has very few frosts and these are restricted to the most continental areas of the interior and high mountains. The average annual temperature shows uniformly high values in the interior and in the low basins of the rivers Almanzora and Almería (17°C and 21°C). They are lower in the upper reaches of the rivers and in the more continental areas.

Sites studied

Appendix 1 lists the 115 sites sampled, all of which appear in Fig. 1. They have been listed in the order of the sierras surveyed (mountain ranges). They were selected to provide the widest climatic, geological, edaphic and altitudinal diversity obtainable in the study area, and include the most suitable habitats for bryophyte development. Where a species was recorded in the recent survey the site numbers are listed after the species name in the following catalogue. Other records are based on the literature cited.

Floristic catalogue

The floristic catalogue of the study area consists of 280 taxa of which 236 are mosses and 44 are liverworts, 74 taxa are reported new for the province of Almería (*), also 31 are new for the Spanish south-east (**) and four are new for the Iberian Peninsula (***). For each taxon the numbers of the sites where they have been found are given. All specimens are in MUB. Also included are bibliographic references for the taxa in the province of Almería, a brief description of the habitat or habitats where they have been collected and, in some cases, additional comments.

The catalogue has been arranged in systematic order, so that the taxa are contained in related groups, although the species have been ordered alphabetically within each genus.

For the liverworts, the nomenclature and sequence of Grolle (1983) has been used, and for the mosses Corley *et al.* (1981) and Corley & Crundwell (1991) have been followed for the systematic sequence and Casas (1991) for the nomenclature.

Analysis of the floristic catalogue

The low proportion of liverworts (Marchantiopsida 16%) stands out in contrast to the mosses (Bryopsida) that represent 84% of the total taxa recorded (Fig. 2a). These values are similar to the ones obtained in neighbouring regions, such as Murcia and Alicante (Ros & Guerra, 1987a; Cano *et al.*, 1996c) but differ from those for the

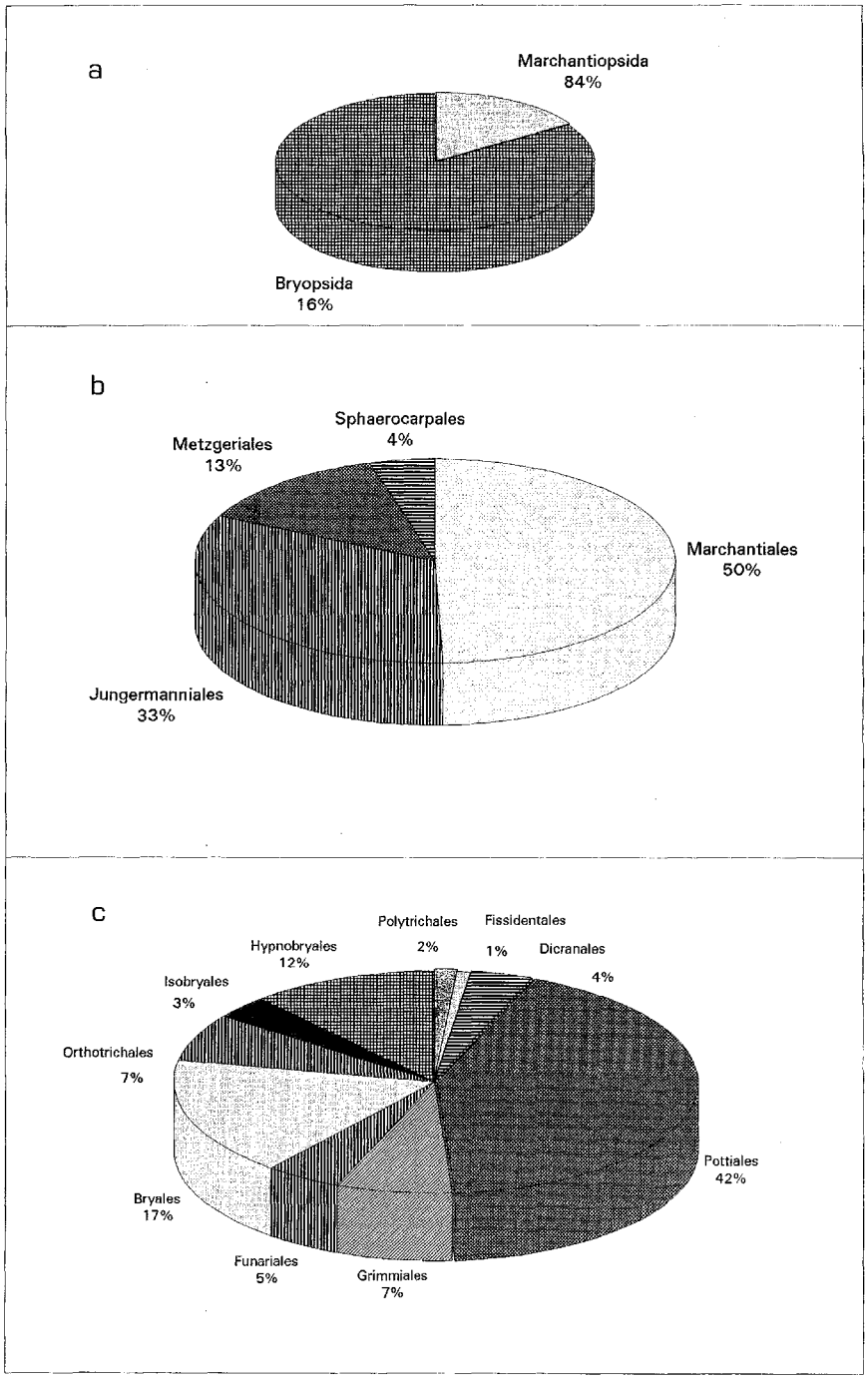

Figure 2. Analysis of the floristic catalogue. a, proportion of taxa of liverworts and mosses. b, percentage of taxa of liverworts in different orders. c, percentage of taxa of mosses in different orders.

Iberian Peninsula as a whole, with percentages of 33% for liverworts and 67% for mosses (Sérgio *et al.* 1994).

As far as mosses are concerned, the order Pottiales is dominant (42%) and the family Pottiaceae outstanding with a percentage of 42%. The other orders with a high number of taxa are: Bryales (17%), Hypnobryales (12%) and Orthotrichales (7%) (Fig. 2b). A clear predominance of the acrocarpic forms (85%) is shown, in comparison to the pleurocarpic mosses (Hypnobryales and Isobryales) (15%).

Within the liverworts, the order Marchantiales is best represented (50%), followed by Jungermanniales (33%), Metzgeriales (13%) and Sphaerocarpales (4%) (Fig. 2c).

In general, these results are to be expected, considering the climatic conditions of the area. The predominance of the family Pottiaceae and the order Marchantiales in mosses and liverworts respectively is common to other arid regions of the world (Frey & Kürschner, 1983) and is evidence of their higher degree of adaptation to these habitats.

Biogeography

A biogeographical consideration of the main chorological elements represented in the study area has been performed by estimating percentages belonging to different distributional types. The types have been taken, when possible, from Düll (1983, 1984, 1985, 1992) or, otherwise from Frey & Kürschner (1983, 1988). The taxa found belong to more than 40 different chorological elements. In view of the similarities of many of these elements we have united them, for statistical and graphical purposes, into nine general chorologic groups: arctic, continental, temperate, mediterranean, sub-mediterranean, oceanic, sub-oceanic, boreal and other distributions. Fig. 3a, b shows, respectively, the absolute and percentage numbers of taxa belonging to these large biogeographic groups.

Many species with temperate (25%), sub-mediterranean (20%), and oceanic (16.0% of which 9.85% are oceanic-mediterranean) distributions are found. There is also a relatively high presence of sub-oceanic (13%) and boreal (13%) distributions. The remaining distribution types present lower percentages: mediterranean 7%, other distributions 3%, continental 2% and arctic 1%.

Outstanding in comparison with other areas of the Iberian south-east is the high proportion of species of wide distribution (temperate, boreal, oceanic, continental and suboceanic) (69%) and the low representation of mediterranean and submediterranean (27%) taxa. This seems to be due to the diversity of physical factors (lithology and climatology, mainly) in comparison with other zones of the Spanish south-east. Thus, many species of wide distribution occur in Sierra de los Filabres. These are commonly found in wetter areas of Spain and Europe, but very rarely in the south-east.

Mosses

**Pogonatum aloides* 17. Very wet banks at the edges of streams.

Polytrichum juniperinum 9, 17, 21. Sierra de los Filabres (Cano & García-Zamora, 1995). Soil accumulated in fissures of schistose rocks and banks near streams.

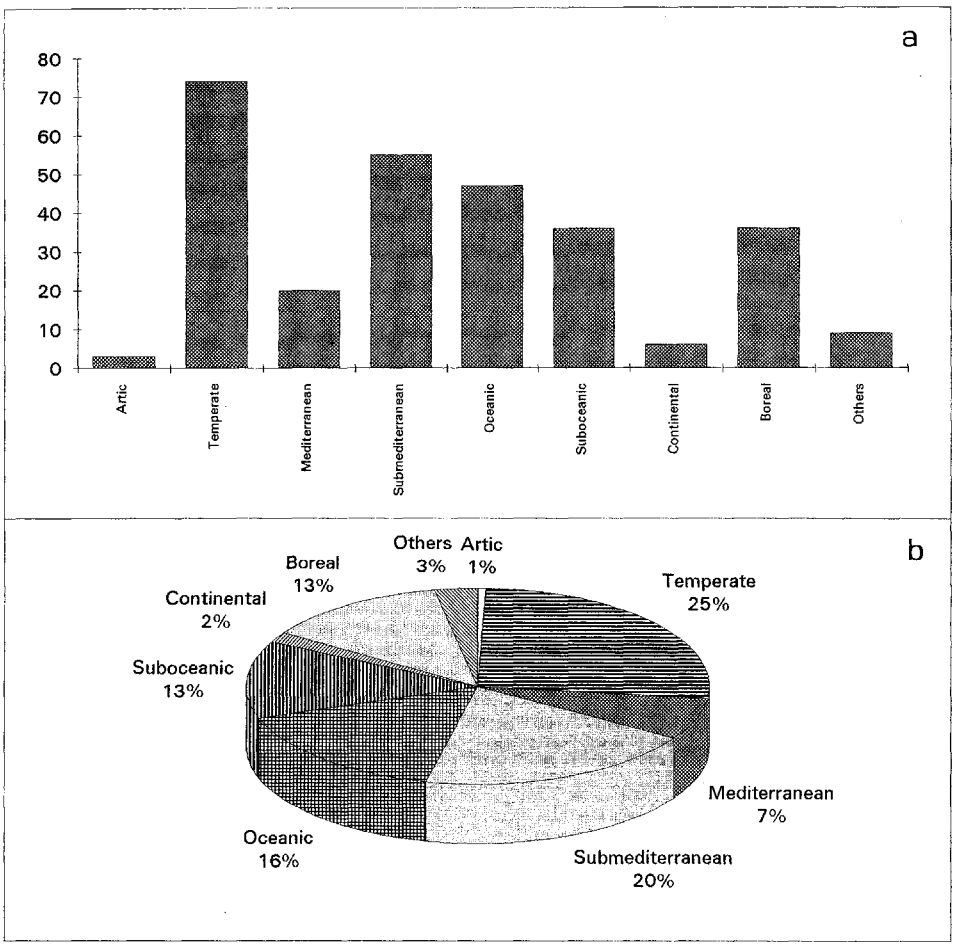

Figure 3. a, Number of taxa present in the study area in relation to different chorological elements considered. b, Percentage of taxa present in the study area in relation to different chorological elements considered.

Polytrichum piliferum Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974). Habitat not indicated.

Atrichum undulatum 9, 12. Sierra de los Filabres (Cano & García-Zamora, 1995). Hollows of schistose rocks, very sheltered, at the edges of streams.

Fissidens bryoides 2, 7, 15, 19, 20, 24, 25, 26, 30, 31, 32, 38, 41, 44, 45, 47, 48, 50, 51, 52, 53, 54, 66, 67, 68, 71, 77, 83, 86, 91, 95, 96, 97, 98, 99, 100, 101, 103, 104, 105, 106, 107, 108, 111, 112, 115. Sierra del Cabo de Gata (Potier de la Varde, 1945, *sub F. bambergeri* Schimp.; Allorge & Casas, 1958, *sub F. bambergeri* Schp. var. *acutiusculus* P. de V.; Acuña *et al.*, 1974, *sub F. bambergeri* Schp. var. *acutiusculus* P. de V.; Guerra & Gil, 1982, *sub F. bambergeri*; Ros & Guerra, 1987b), Almería (Allorge & Allorge, 1946, *sub F. bambergeri* Schmp.), Aguadulce (Allorge & Casas,

1958, *sub. F. bambergeri* Schp.), Huércal (Guerra & Gil, 1982), sierra Cabrera (Martínez-Sánchez, 1990, *sub F. incurvus* Starke ex Röhl.; Guerra, Martínez-Sánchez & Ros, 1992a, *sub F. incurvus* Starke ex Röhl). Soils from acidic to basic in cracks of rocks.

**Fissidens taxifolius* 9, 11, 12, 17. Rocks, more or less submerged and sheltered, at the edges of streams.

**Dicranum scoparium* 21. Banks at the bases of acidic rocks.

Dicranella howei 2, 4, 22, 29, 32, 33, 34, 38, 44, 46, 47, 48, 49, 50, 51, 52, 54, 58, 59, 60, 79, 85, 86, 87, 88, 89, 91, 92, 94, 100, 108, 115. Venta de los Yesos (Ros & Guerra, 1987b, *sub Anisothecium howei*), Sierra de Cabrera (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). On many dry, mineral-rich soils.

Dicranella varia 6, 12, 47. Sierra del Cabo de Gata (Acuña *et al.* 1974, *sub Anisothecium varium* (Hedw.) Mitt.). Very stony soils and protosoils and on soil on rocks.

Cynodontium bruntonii Sierra de los Filabres (Cano & García-Zamora, 1995). In cracks of metamorphic rocks and banks at the edges of streams.

Cheilothela chloropus Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974). Clayey soil.

Ceratodon conicus Sierra Cabrera (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Gypsiferous soil.

**Ceratodon purpureus* 5, 9, 11, 13, 15, 16, 17, 21 74, 78. Rocky, dry or temporarily wet soils.

Ditrichum cylindricum Sierra de los Filabres (Cano & García-Zamora, 1995). Humiferous soil on schists temporarily flooded by melt-water.

**Pleuridium acuminatum* 17. Banks with soil of acidic nature at the edges of streams.

***Encalypta spathulata* 34. Fissures of rocks in banks shaded by herbaceous plants. It is close to *E. vulgaris* and *E. rhaptocarpa.* A comparison of the features for distinguishing this species is given in Table 1, based on data from Horton (1983) for the sporophytes and gametophytes, and from Alvaro (1994) for the spores.

Encalypta vulgaris 1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 23, 26, 27, 30, 31, 32, 33, 35, 36, 38, 41, 42, 50, 51, 53, 54, 59, 60, 63, 64, 65, 66, 67, 70, 73, 74, 75, 77, 78, 79. Sierra de Alhamilla (Allorge & Casas, 1958), Yesoncillo de Enmedio and sierra Cabrera (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Protosoils and rocky soils, generally sheltered.

Tortula atrovirens 1, 2, 30, 31, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 47, 55, 57, 59, 61, 63, 67 73, 83, 90, 95, 96, 99, 100, 101, 103, 104, 105, 106, 107, 108, 109, 111, 112, 113, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958, *sub Desmatodon convolutus* (Brid.) Grout.; Acuña *et al.*, 1974), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), El Alquián (Hébrard & Pierrot, 1994). On exposed saline and nitrified soils, and at bases of basaltic rocks with accumulated soil.

Table 1. *Comparison of distinguishing features of* Encalypta spathulata, E. vulgaris *and* E. rhaptocarpa.

	E. spathulata	*E. vulgaris*	*E. rhaptocarpa*
Leaves	Green to dark-brown costa that forms a narrow and inconspicuous keel on the abaxial surface	Golden-brown costa that forms a prominent keel on the abaxial surface	Green to brown costa that forms a narrow and inconspicuous keel on the abaxial surface
Leaf hair-point	Present	Absent	Present
Basal cells	Prominent, with orange transverse and yellowish longitudinal walls	Inconspicuous	Prominent, with dark-red to orange longitudinal and transverse walls
Capsule	With longitudinal ribs	Smooth to delicately striate	With longitudinal ribs
Peristome	Absent	Absent	Present and well-developed
Calyptra	Pale-golden and almost transparent	Pale-golden more-or-less opaque	Golden and opaque
Spores	32.7-(34.8)-37 × 26.8-(27)-29 μm, with large verrucate protuberances μm high) on the distal surface and narrow, radial plicate on the proximal surface	24.9-(28.8)-33 × 23-(25)-2 μm, with more-or-less prominent verrucae (3–4 μm high) on the distal surface and narrow, radial plicate on the proximal surface	37-(39.8)-43 × 25-(27.3)-30 μm, with numerous, large verrucae (3–3.5 μm high) on the distal surface, and narrow, radial plicate with some gemmae centrally on the proximal surface

Tortula brevissima 107, 108. Venta de los Yesos (Ros & Guerra, 1985), between Lucainena de las Torres and Sorbas (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Clayey, muddy, gypsiferous or saline soils and protosoils.

Tortula canescens 38, 60, 79, 100. Sierra del Cabo de Gata (Acuña *et al.*, 1974). In fissures of rocks of varied nature or protosoils, sometimes on sheltered banks.

Tortula caninervis subsp. *spuria* Venta de los Yesos (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a; Martínez-Sánchez, Ros & Guerra, 1991). Banks with crystalline gypsum (*cf.* Martínez-Sánchez, 1990).

Tortula cuneifolia var. *cuneifolia* 16, 104. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Tortula cuneifolia* (Dicks.) Roth.; Acuña *et al*, 1974). On basaltic rocks, sometimes temporarily wet.

****Tortula cuneifolia* var. *marginata* 30, 35, 38, 98, 103, 104, 112. Soils on rocky slopes and siliceous rocks.

**Tortula inermis* 11, 12, 34, 41, 62, 64, 66, 70, 72, 73, 76, 77. Humiferous soils at the base of rocks of acidic nature.

**Tortula intermedia* 17, 21, 52, 75. Fissures of schistose rocks and soil accumulated on rocky ledges. Sometimes epiphytic on *Quercus rotundifolia.*

Tortula israelis 51, 64, 67, 86, 100, 103. Mojácar (Guerra, Ros & Carrión, 1992b, *sub Tortula baetica*). *Tortula baetica* has recently been synonymized with *Tortula israelis* (Cano, Guerra & Ros, 1996a). Shaded banks under rocks and in fissures.

**Tortula laevipila* 69, 80. Epiphytic on *Quercus rotundifolia.*

**Tortula muralis* var. *muralis* 20, 25, 30, 32, 34, 35, 41, 42, 44, 47, 48, 52, 62, 63, 67, 68, 70, 71, 72, 78, 92, 103. Accumulated soil in fissures of rocks and exposed rocks.

**Tortula muralis* var. *aestiva* 13, 20, 30, 34, 35, 67. Bases of sheltered rocks.

Tortula muralis var. *incana* Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Tortula muralis* (L.) Hedw. fo. *incana*), several sites (Acuña *et al.*, 1974, *sub Tortula muralis* fo. *incana* Sapehin). On rocks.

Tortula muralis var. *obcordata* 43, 45. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub Tortula muralis* fo. *obcordata* Moenk.), Sierra Cabrera (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), Sierra de María (Guerra *et al.*, 1992b). Fissures of schistose rocks and shaded rocky banks.

**Tortula princeps* 75. Soil in *Quercus rotundifolia* wood.

Tortula revolvens var. *obtusata* 44. Aguadulce (Allorge & Casas, 1958, *sub T. fiorii* Vent.; Ros & Guerra, 1985), venta de los Yesos (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra, Martínez-Sánchez, Ros & Carrión, 1990; Guerra *et al.*, 1992a). On gypsiferous or loamy-gypsiferous soils.

**Tortula ruraliformis* 9, 11, 12, 21, 75, 77. On sheltered banks and epiphytic on the bases of trunks.

Tortula ruraliformis var. *subpapillosissima* 80. Sierra de los Filabres (Ros & Guerra, 1985). Acidic and exposed rocks.

Tortula ruralis 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 23, 26, 31, 33, 38, 41, 62, 64, 66, 67, 69, 70, 71, 72, 73, 74, 76, 80. Sierra de los Filabres (Alcaraz *et al.*, 1982). Banks next to streams and both acidic and basic rocks. Occasionally epiphytic.

**Tortula subulata* var. *subulata* 3, 7, 8, 9, 11, 12, 14, 15, 16, 17, 18, 21, 27, 36, 69, 75. Very humiferous soils temporarily wet as a result of meltwater, fissures of rocks and epiphytic at the bases of trunks.

**Tortula subulata* var. *subinermis* 3, 5, 7, 11, 12, 14, 15, 17, 18, 19, 26, 31, 32, 41, 47, 65, 71, 74, 76, 77. Ledges with soil in hollows among rocks, sometimes at the edges of streams.

Tortula vahliana 35, 90, 100, 104, 106, 107. Sierra del Cabo de Gata (Acuña *et al.*, 1974). Banks and bases of rocks, exposed soils and dry, generally saline and gypsiferous.

Aloina aloides 34, 35, 37, 39, 40, 42, 43, 44, 45, 46, 47, 48, 50, 55, 57, 59, 61, 62, 66, 67, 68, 70, 79, 86, 87, 88, 95, 97, 101, 102, 103, 104. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub A. aloides* (Koch) Kindb.; Acuña *et al.*, 1974), Viator (Guerra

& Gil, 1982), several sites (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Dry, non-humiferous soils (limy, saline, loamy, gypsiferous and clayey).

Aloina ambigua 1, 34, 36, 37, 38, 41, 43, 44, 46, 47, 49, 50, 52, 53, 55, 56, 59, 78, 79, 82, 84, 86, 88, 90, 91, 101, 109, 111. Sierra del Cabo de Gata (Allorge & Casas, 1958), several sites (Acuña *et al.*, 1974, *sub A. rigida* () Limpr. var. *ambigua* (B.S.G.) Craig.; Ros & Guerra, 1987b, *sub Aloina aloides* (K. F. Schultz) Kindb. var. *ambigua* (Bruch & Schimp.) Craig), cortijo de Paulico (Ros, Guerra, Heras-Ibáñez, García-Zamora & Jiménez, 1989), several gypsiferous outcrops (Martínez-Sánchez, 1990). Stony, deep, and exposed soils.

Aloina bifrons Aguadulce (Allorge & Casas, 1958, *sub A. rigida.* fo. *pilifera* Br. Eur.), venta de los Yesos (Ros & Guerra, 1985; Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a, Sierra del Cabo de Gata (Hébrard & Pierrot, 1994). Bare and dry soils, limy, loamy-limy and gypsiferous.

Aloina rigida 36, 46, 47, 50, 85, 98, 100, 101. Aguadulce (Allorge & Casas, 1958). Rocky banks, sometimes with flowing water.

**Pterygoneurum compactum* 42, 55. It occurs on very dry, generally unshaded, soils that are rich in salts (saline and gypsiferous).

Pterygoneurum lamellatum 37, 56. Cruce a Turrillas (Ros *et al.*, 1989). Dry exposed soils, generally loamy or clayey.

Pterygoneurum ovatum 16, 18, 26, 27, 34, 57, 82, 84, 89, 90, 102. Sierra del Cabo de Gata (Acuña *et al.*, 1974), several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.* , 1992a; Guerra, Cano & Ros, 1995). Stony meadows with dry soils, gypsiferous or loamy.

Pterygoneurum sampaianum 44, 52, 66. Cruce a Turrillas (Ros *et al.*, 1989; Guerra *et al.*, 1995), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), Las Palomas (Guerra *et al.*, 1995). Protosoils and gypsiferous or loamy-gypsiferous soils.

Pterygoneurum subsessile 34, 57. Gypsiferous outcrop of Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), Llano del Duque (Guerra *et al.*, 1995). Sandy and loamy-clayey soils, generally enriched with salts.

Crossidium aberrans 1, 34, 36, 40, 43, 47, 52, 59, 62, 66. Cortijo de Paulico (Ros *et al.*, 1989), gypsiferous outcrops of Cuenca de Sorbas and Yesoncillo de Enmedio (Gérgal) (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), several sites (Cano, 1992). A world taxonomic revision of the genus *Crossidium* has been carried out (Cano, Guerra & Ros, 1993). It grows on basic soils of different types (limy, gypsiferous, loamy-gypsiferous). Sometimes on soil that is lightly nitrified and on soil accumulated on rocks.

Crossidium crassinerve 34, 43, 44, 46, 47, 49, 50, 53, 55, 56, 57, 59, 60, 67, 79, 84, 86, 88, 89, 90, 109. Sierra Alhamilla, Aguadulce y Roquetas (Allorge & Casas, 1958, *sub C. chloronotos* (Brid.) Limpr.), several sites (Fuertes, 1983), venta de los Yesos y entre Lucainena de las Torres y Sorbas (Ros & Guerra, 1987b), cruce a Turrillas

y cortijo de Paulico (Ros *et al.*, 1989), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), several sites (Cano, 1992), sierra del Cabo de Gata y El Alquián (Hébrard & Pierrot, 1994). On more or less dry, loamy, gypsiferous and clayey soils.

Crossidium laevipilum Gypsiferous outcrops in Cuenca de Sorbas and in Yesoncillo de Enmedio (Martínez-Sánchez, 1990, *sub C. crassinerve* (De Not.) Jur. var. *laevipilum* Delg.), several sites (Cano, 1992). Cleared zones of pastures and other soils developed on gypsum.

Crossidium seriatum 30, 101. Gypsiferous outcrop of Yesoncillo de Enmedio (Cano, 1992). On gypsiferous or loamy-gypsiferous soils, sometimes lightly saline, in very dry zones.

Crossidium squamiferum 29, 34, 35, 36, 37, 40, 41, 42, 43, 46, 47, 49, 51, 56, 61, 88. Aguadulce y Roquetas (Allorge & Casas, 1958, *sub Crossidium squamigerum* (Viv.) Jur.), sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub Crossidium squamigerum* (Viv.) Jur.), several sites (Fuertes, 1983; Cano, 1992), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Soils, banks, fissures, cracks with accumulated soil, walls and rocks of lime or of a loamy nature.

***Desmatodon guepinii* 115. Unshaded stony soils.

Pottia caespitosa 52, 79. Several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). 56). Slaty soil on sheltered slopes.

Pottia davalliana 1, 18, 30, 34, 44, 46, 49, 52, 56, 57, 59, 62, 66, 79, 82, 83, 84, 88, 90, 95, 97, 99, 100, 101, 103, 104, 106, 107, 108, 109, 110, 111, 113, 114, 115. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub Pottia davalliana* (Sm.) C. Jens. ssp. *commutata* (Limpr.) Podp.), Viator y Huércal (Guerra & Gil, 1982), Turre (Martínez-Sánchez, 1990, *sub Pottia commutata* Limpr.), gypsiferous zones (Guerra *et al.*, 1992a, *sub P. commutata* and *P. minutula*), gypsiferous outcrop of Lomilla de las Colmenas (Martínez-Sánchez, 1990, *sub Pottia starckeana* (Hedw.) C. Müll. subsp. *minutula* (Schleich. ex Schwaegr.) D. Chamb.). Clayey landings and dry, loamy soils, sometimes rich in salts. For the *Pottia starckeana* complex the taxonomic treatment of Ros *et al.* (1996) has been followed.

Pottia intermedia 13, 34, 36, 41. Sierra del Cabo de Gata (Acuña *et al.*, 1974), punta Entinas (Ros & Guerra, 1987b, doubtful citation, probably it is *P. pallida*, but it is not possible to confirm it because the specimen is not preserved in a herbarium). Sheltered wet stony banks.

Pottia lanceolata 1, 2, 4, 11, 34, 36, 41, 43, 52, 59, 82, 104. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974), several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Bases of rocks and on well-developed soils.

**Pottia pallida* 98, 101, 102, 110. It appears in salt marshes and stony soils under *Chamaerops humilis*.

Pottia starckeana 1, 2, 31, 33, 34, 35, 36, 37, 38, 40, 42, 43, 44, 45, 46, 47, 50, 52, 53, 54, 56, 59, 61, 62, 77, 79, 88, 93, 96, 97, 100, 102, 103, 104, 106, 107, 110, 111,

115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974; Carrión, Ros & Guerra, 1993), cruce a Turrillas (Ros *et al.*, 1989), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1990; Guerra *et al.*, 1992a). More or less dry, non-humiferous soils.

Pottia starckeana aggr. 1, 30, 34, 41, 42, 44, 46, 47, 48, 50, 52, 57, 86, 90, 91, 92, 94, 98, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 114, 115. Near venta de los Yesos (Tabernas) (Ros & Guerra, 1987b, *sub P. mutica* Vent.), gypsiferous outcrops of venta de los Yesos and Yesoncillo de Enmedio (Martínez-Sánchez, 1990, *sub P. mutica* Vent.; Guerra *et al.*, 1992a, *sub P. mutica*). Well-developed soils, exposed or shaded, and accumulated soil among rocks.

Pottia wilsonii 31, 35, 38, 86, 101, 104. Sierra de los Filabres (Cano & García-Zamora, 1995). Wet banks at the bases of metamorphic rocks, stony, lightly shaded meadows and protosoils.

Phascum curvicolle 44, 47, 52, 57, 59, 82, 101. Sierra Alhamilla (Casas, 1973), cruce a Turrillas (Ros *et al.* 1989; Guerra, Jiménez, Ros & Carrión, 1991), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1990; Guerra *et al.*, 1992a). Loamy-clayey soils in openings among bushes and protosoils among rocks.

Phascum cuspidatum var. *cuspidatum* 5, 15, 16, 18, 31, 35, 101. Sierra del Cabo de Gata (Acuña *et al.*, 1974). Bare soils and exposed protosoils among rocks.

**Phascum cuspidatum* subsp. *papillosum* 77. Soil protected by herbaceous plants.

Phascum cuspidatum var. *piliferum* 1, 12, 16, 26, 27, 30, 35, 36, 38, 40, 65. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub P. piliferum* Schreb.; Casas, 1974; Acuña *et al.*, 1974). Sandy siliceous soils, soil accumulated at the bases of basaltic rocks and in temporarily wet meadows.

Phascum cuspidatum var. *retortifolium* 11, 16, 17, 18, 26, 101, 103, 104, 105, 106, 107, 108. Sierra del Cabo de Gata (Guerra *et al.*, 1991). Wet meadows and banks receiving meltwater, sheltered, protosoils among rocks and fissures of rocks.

Phascum cuynetii 44, 83, 98, 101, 115. Gypsiferous outcrop of Cerro de las Cuevas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), several sites (Guerra *et al.*, 1991). Earth accumulated in fissures of rocks, bare soils in openings among bushes, exposed protosoils among rocks and stony banks.

Phascum longipes 59, 83. Several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1990; Guerra *et al.*, 1991; Guerra *et al.*, 1992a). Bases and fissures of rocks (sandy and loamy).

Acaulon dertosense 37, 93. Cruce a Turrillas (Ros *et al.*, 1989), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Clayey, exposed, very dry soils, sometimes nitrified.

Acaulon fontiquerianum 1, 34, 35, 37, 103. Sierra del Cabo de Gata (Casas & Sérgio, 1990). Protected banks and very dry clayey soils, sometimes nitrified.

**Acaulon mediterraneum* 100. Stony slopes with herbaceous plants.

Acaulon triquetrum 16, 34, 40, 43, 44, 50, 52, 57, 59, 66, 89, 90, 97, 101, 103, 104, 105, 106, 107, 108, 109, 110, 114, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974; Casas, 1974), several sites (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Bare protosoils, sandy, loamy-clayey or saline soils, very exposed and hummocks among rocks.

**Barbula convoluta* 1, 7, 25, 33, 34, 35, 44, 47, 49, 52, 53, 54, 59, 62, 66, 78, 86, 88, 89, 101, 104, 108. Clayey or sandy banks and protosoils, edges of river beds and bases of rocks by running water.

Barbula unguiculata 1, 2, 7, 11, 20, 22, 24, 25, 29, 30, 32, 34, 36, 38, 41, 42, 45, 46, 47, 50, 53, 55, 60, 66, 67, 68, 69, 70, 71, 72, 74, 76, 78, 79, 87, 89, 91, 97, 101, 103, 104, 107, 108, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974; Guerra & Gil, 1982), punta del Sabinar (Guerra & Puche, 1984), several sites (Ros & Guerra, 1987b), (Martínez-Sánchez, 1990; Guerra *et al.*, 1990; Guerra *et al.*, 1992a). Meadows, protosoils, banks and fissures of rocks with clayey or sandy soils, sometimes with running water and nitrified.

Leptobarbula berica 44, 46. Gypsiferous outcrops of Mojácar and Lomilla de las Colmenas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Rocks with accumulated soil.

Pseudocrossidium hornschuchianum 2, 5, 7, 11, 15, 16, 21, 23, 26, 27, 30, 34, 35, 39, 42, 43, 44, 46, 47, 50, 52, 55, 56, 61, 62, 67, 70, 73, 75, 78, 79, 82, 89, 94, 95, 98, 100, 101, 104, 107, 108, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958, *sub Barbula hornschuchiana* Schultz.; Acuña *et al.*, 1974, *sub B. hornschuchiana* Schultz.), several sites (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Protosoils and stony soils very dry and exposed, clayey, sandy, siliceous and loamy.

Pseudocrossidium revolutum 47, 62. Aguadulce y Sierra del Cabo de Gata (Allorge & Casas, 1958, *sub Barbula revoluta* (Schrad.) Brid.), between Senés and the lighthouse (Acuña *et al.*, 1974, *sub B. revoluta* Brid.), gypsiferous outcrops of Loma de los Yesares and Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Smooth acidic rocks.

Trichostomopsis aaronis 1, 31, 34, 36, 38, 44, 56, 61, 64, 66, 72, 78, 103, 104, 107. Yeseras de Tabernas (Guerra & Ros, 1987, *sub Didymodon aaronis* (Lor.) Guerra), several gypsiferous outcrops (Martínez-Sánchez, 1990, *sub D. aaronis* (Lor.) Guerra; Guerra *et al.*, 1992a, *sub D. aaronis*), playa del Retamar, El Alquián (Hébrard & Pierrot, 1994, *sub D. aaronis* (Lor.) Guerra). More or less sheltered banks and bare sandy siliceous soils.

Trichostomopsis australasiae 7, 22, 23, 25, 29, 30, 32, 34, 35, 36, 38, 40, 41, 42, 62, 64, 66, 67, 71, 76, 86, 98, 100, 101, 104, 108, 115. Several gypsiferous outcrops (Martínez-Sánchez, 1990, *sub Didymodon australasiae* (Hook. & Grev.) Zander; Guerra *et al.*, 1992a). Sandy or stony soils, normally very sheltered and very humiferous banks among rocks.

Trichostomopsis trivialis 2, 7, 30, 34, 64, 74, 86, 107, 108. Gypsiferous outcrops of Cuenca de Sorbas and Yesoncillo de Enmedio (Gérgal) (Martínez-Sánchez, 1990,

sub Didymodon trivialis (C. Müll.) Guerra; Guerra *et al.*, 1992a, *sub D. trivialis*). Lightly sheltered stony slopes, accumulated soil at the bases of walls or rocks and fissures of rocks sometimes with accumulated protosoil.

Trichostomopsis umbrosa Sierra del Cabo de Gata (Casas, 1974; Acuña *et al.*, 1974; Guerra & Ros, 1987). Nitrified banks and soils.

Didymodon acutus 45, 55, 56, 58, 66, 67, 86, 88, 108. Aguadulce (Allorge & Casas, 1958, *sub Barbula acuta* (Brid.) Brid.), several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Stony soils, sandy-loamy, sheltered and very wet hollows of rocks.

Didymodon fallax 34, 48, 58, 103, 104. Aguadulce (Allorge & Casas, 1958, *sub Barbula fallax*), sierra del Cabo de Gata (Allorge & Casas, 1958, *sub B. fallax*; Acuña *et al.*, 1974, *sub B. fallax*, Hedw.), several sites (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Hollows of rocks on wet rocky banks.

**Didymodon ferrugineus* 58. Calcareous banks.

Didymodon insulanus 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 29, 30, 31, 32, 34, 35, 36, 38, 41, 42, 45, 47, 48, 50, 52, 55, 59, 62, 63, 64, 66, 67, 68, 69, 71, 73, 74, 75, 76, 77, 78, 79, 86, 88, 95, 97, 98, 104, 106, 108, 112, 115. Gypsiferous outcrops of Cuenca de Sorbas and Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Accumulated earth in fissures or at the bases of shaded basic rocks.

Didymodon luridus 1, 2, 7, 11, 14, 24, 25, 29, 30, 31, 32, 33, 34, 35, 36, 37, 41, 42, 43, 44, 45, 46, 47, 48, 50, 51, 52, 54, 55, 56, 59, 61, 62, 63, 66, 67, 68, 70, 71, 72, 79, 83, 86, 87, 88, 89, 91, 92, 97, 100, 101, 103, 108, 111, 115. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub D. trifarius* (Hedw.) Roehl.), Punta del Sabinar (Guerra & Puche, 1984), several gypsiferous outcrops (Ros & Guerra, 1987b, *sub D. trifarius*; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). It occurs in the same habitats as other species of the genus such as *D. acutus* or *D. fallax* with which it is often associated.

Didymodon rigidulus 12, 13, 18, 23, 25, 29, 33, 37, 44, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 58, 59, 60, 61, 64, 66, 67, 70, 73, 74, 78, 83, 84, 85, 86, 88, 95, 98, 99, 101, 102, 103, 115. Several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Soils, generally dry, and in the same conditions as the other species of the genus such as *D. luridus.*

Didymodon sicculus 44, 47, 55, 58, 60, 68, 88, 89, 101, 102, 103, 107. Sierra del Cabo de Gata, sierra Alhamilla (Cano, Ros, García-Zamora & Guerra, 1996b). Dry bare soils of varying kinds (sandy, clayey or saline) and protosoils accumulated among rocks.

Didymodon tophaceus 4, 37, 38, 78, 81. Sierra Alhamilla (Allorge & Casas, 1958, *sub Barbula tophacea* (Brid.) Mitt.). Seeping banks by running water that can be occasionally submerged.

Didymodon vinealis 1, 2, 4, 7, 9, 10, 11, 12, 14, 17, 19, 20, 23, 24, 25, 26, 27, 30, 31, 32, 33, 34, 35, 36, 38, 40, 41, 42, 43, 44, 46, 47, 48, 50, 51, 52, 54, 55, 56, 58, 59, 60, 61, 62, 66, 67, 68, 69, 70, 71, 72, 73, 74, 76, 77, 78, 79, 86, 87, 88, 89, 91, 92, 95, 97,

98, 100, 101, 102, 103, 104, 106, 107, 108, 112, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Barbula vinealis* Brid.; Acuña *et al.*, 1974, *sub B. vinealis* Brid.), several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). It occurs in the same habitats as other species of the genus such as *D. fallax, D. rigidulus,* etc.

**Bryoerythrophyllum recurvirostrum* 9, 11, 13, 14, 17, 22. Soil among rocks and humiferous banks at the edge of streams.

Eucladium verticillatum 37. Sierra del Cabo de Gata (Guerra & Gil, 1982), barranco de la Mina (Dia, 1991). Accumulated soil on seeping walls.

Gyroweisia reflexa Huércal y Viator (Guerra & Gil, 1982). Limy cement of conglomerated, shaded artificial walls and rocks with protosoil (cf. Guerra & Gil, 1982).

Gyroweisia tenuis Sierra de Alhamilla (Allorge & Casas, 1958). Under bushes of *Artemisia barrelieri.*

Gymnostomum calcareum 44, 46, 47. Sierra del Cabo de Gata (Acuña *et al.*, 1974; Guerra & Gil, 1982). Slopes with run-off and supravertical rocky walls.

Gymnostomum lanceolatum 41, 45, 46, 48, 50. Several gypsiferous outcrops (Martínez-Sánchez, 1990, *sub G. mosis* (Lor.) Jur. & Mild.; Martínez-Sánchez *et al.*, 1991, *sub G. mosis*; Guerra *et al.*, 1992a, *sub G. mosis*; Cano, Ros & Guerra, 1994). Soils, banks in hollows and accumulated protosoils on rocks.

Gymnostomum viridulum 34, 37, 41, 44, 45, 46, 47, 48, 49, 50, 51, 53, 58, 59, 63, 67, 68, 79, 83, 85, 86, 87, 89. Sierra del Cabo de Gata (Sérgio, 1984), several sites (Ros & Guerra, 1987b, *sub G. luisieri*), several gypsiferous outcrops (Martínez-Sánchez, 1990, *sub G. luisieri*; Guerra *et al.*, 1992a, *sub G. luisieri*). Banks, soils, protosoils and fissures of rocks.

**Hymenostylium recurvirostrum* 3, 4, 21, 37. Accumulated soil on ledges of rocks and partly submerged in edges of rivers.

Trichostomum brachydontium var. *brachydontium* 3, 12, 31, 32, 33, 34, 37, 38, 41, 44, 45, 46, 47, 48, 50, 51, 52, 53, 54, 59, 60, 62, 63, 67, 79, 83, 85, 86, 87, 88, 91, 92, 94, 95, 98, 99, 100, 101, 103, 104, 106, 107, 108, 110, 112, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.,* 1974), between Lucainena de las Torres and Sorbas (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et* 1992a). On all kinds of soils and protosoils.

Trichostomum brachydontium var. *littorale* Gypsiferous outcrops of Lomilla de las Colmenas and cuenca de Sorbas (Martínez-Sánchez, 1990). With similar ecology to the typical variety.

Trichostomum crispulum 1, 17, 31, 33, 34, 35, 38, 41, 44, 45, 47, 48, 49, 50, 52, 58, 59, 60, 67, 71, 79, 82, 83, 85, 99, 100, 101, 105, 106, 107, 111, 112. Several gypsiferous outcrops (Ros & Guerra, 1987b; Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Soils and rocky banks, sometimes humiferous soils in very dry zones.

Weissia brachycarpa 4, 9, 15, 18, 47, 52, 77, 107. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Hymenostomum microstomum* (Hedw.) R. Br.; Acuña *et al.*, 1974, *sub H. microstomum* (Hedw.) R. Brown). Banks and soils at the bases of rocks and edges of streams.

Weissia condensa 9, 62, 91, 92, 95, 100. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Hymenostomum tortile* (Schw.) Bryol. Eur.; Acuña *et al.*, 1974, *sub H. tortile* (Schwaegr.) D.S.G.). Hollows at the bases of rocks, fissures of rocks and sandy banks.

Weissia controversa 1, 3, 11, 14, 15, 19, 22, 40, 41, 44, 47, 54, 64, 68, 73, 76, 88, 96, 97, 99, 100, 103, 104, 106, 108, 113, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub W. viridula* (L.) Hedw.; Allorge & Casas, 1958; Acuña *et al.*, 1974; Guerra & Gil, 1982, *sub Weissia viridula*). Aguadulce (Allorge & Allorge, 1946; Ros & Guerra, 1987b), Viator (Guerra & Gil, 1982, *sub Weissia viridula*), gypsiferous outcrop of cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Edges of streams, accumulated soil on rocks, volcanic rocks among herbaceous plants and fissures.

Weissia fallax 47, 106, 111. Sierra del Cabo de Gata (Acuña *et al.* 1974, *sub Weissia controversa* Hedw. var *crispata* (Nees & Hornsch.) Nyholm). Protosoils and deep soils, fissures of limy rocks and among volcanic rocks.

Weissia levieri 31. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub Astomum crispum* Hampe var. *philibertii* (Husn.) Wijk & Marg.). Stony sheltered banks.

Weissia longifolia 33, 97, 100, 103, 104, 106, 107. Sierra del Cabo de Gata (Allorge & Casas, 1958, *sub Astomum crispum* (Hedw.) Hampe.; Acuña *et al.*, 1974, *sub A. crispum* (Hedw.) Hampe). Bases of rocks with accumulated soil, protosoils and deeper soils among rocks.

Weissia triumphans 35, 38, 49, 51, 59, 79, 83. Several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Rocks generally sheltered by bushes and hollows at the bases of rocks.

Aschisma carniolicum var. *speciosum* Sierra Alhamilla (Casas, 1973). Clayey soils in openings among bushes.

Pleurochaete squarrosa 1, 2, 20, 23, 24, 25, 29, 30, 31, 32, 33, 34, 35, 37, 38, 41, 42, 44, 45, 46, 47, 50, 51, 52, 58, 59, 60, 61, 62, 63, 64, 66, 67, 68, 70, 71, 75, 77, 86, 94, 95, 96, 98, 99, 100, 101, 104, 108. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974), punta del Sabinar (Guerra & Puche, 1984), Alhama de Almería (Ros & Guerra, 1987b), Gypsiferous outcrops of Cuenca de Sorbas and Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Humiferous soils and dry soils with low organic content. Also small fissures of rocks with accumulated soil and clayey ledges.

Tortella flavovirens var. *flavovirens* 60, 91, 97, 100, 103, 104, 106, 107, 110, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974, *sub T. flavovirens* var. *viridiflava* (De Not.) Cas.-Gil; Ros & Guerra, 1987b), sierra Alhamilla (Allorge & Casas, 1958), punta del Sabinar (Guerra & Puche, 1984). Earth among basic rocks and protosoils without vegetation.

**Tortella flavovirens* var. *papillosissima* 95, 96, 99, 103, 111, 112, 115. Stony soils, and sheltered protosoils.

Tortella humilis 92, 96. Gypsiferous outcrop of cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Accumulated soil among rocks.

Tortella nitida 47, 51, 52, 62, 63, 81, 86, 103, 108, 114. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974). Protosoils of volcanic nature and fissures of limy rocks.

**Tortella tortuosa* 4, 10, 26, 99, 103. Rocks and fissures with accumulated soil.

Timmiella barbuloides 34, 44, 47, 48, 50, 94. Sierra del Cabo de Gata (Acuña *et al.*, 1974). Wet sheltered banks. Cracks and bases of rocks.

**Schistidium apocarpum* 4. Limy exposed rocks, sometimes with accumulated soil.

**Schistidium confertum* 9, 10, 11, 17. Rocks of acidic nature next to streams.

Schistidium flaccidum 10, 11, 15, 17, 21, 26. Sierra de Gador (Casares-Gil, 1915, *sub Schistidium sphaericum* (Schrp.) Roth), sierra de los Filabres (Cano & García-Zamora, 1995). Schistose rocks near running water.

****Schistidium pulchrum* 21. Base of rock of acidic nature. According to Blom (1996) it grows in wet zones of coniferous woods, woods of deciduous trees and ledges of rocks.

***Schistidium singarense* 12, 13. Walls near of streams. According to Blom (1996) it grows on calcareous rocks or, less frequently, on igneous rocks. It is a species characteristic of sunny exposed places, but in wet places, sometimes on slopes facing north.

Grimmia capillata El Tablazo (Guerra *et al.*, 1993, *sub Grimmia mesopotamica* Schiffn.). Banks with gypsiferous soil.

Grimmia crinita Gypsiferous outcrop of Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Exposed rocks, soil at the bases of rocks and temporarily wet banks.

Grimmia laevigata 10, 19, 31, 38, 64, 77, 80, 103. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub G. campestris* Burch.; Acuña *et al.*, 1974). Volcanic and metamorphic rocks, sometimes with accumulated soil.

Grimmia lisae 38, 64, 77, 80. Barranco del Huelí (Cano & García-Zamora, 1995, *sub Grimmia trichophylla* Grev. var. *meridionalis* Schimp.). Gypsiferous rocks.

***Grimmia montana* 9, 11, 17, 21. Acidic rocks, sometimes with accumulated soil.

Grimmia orbicularis 41, 47, 51, 52, 62, 77, 80. Several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Rocks of acidic or basic nature, sometimes cracked and with accumulated soil.

***Grimmia ovalis* 9, 10, 11, 15, 17, 18, 21, 26, 38, 52, 63, 77, 80, 91. Siliceous rocks, sometimes with accumulated soil.

Grimmia pitardii 1, 44, 50, 86. Níjar y El Mónsul (Casas, 1973), Sierra del Cabo de Gata (Acuña *et al.*, 1974), Almería (Casas *et al.*, 1981), several gypsiferous outcrops

(Martínez-Sánchez, 1990; Guerra *et al.*, 1990; Guerra *et al.*, 1992a). Sheltered banks on stony slopes and bare soils in openings among bushes.

Grimmia pulvinata var. *pulvinata* 3, 5, 7, 9, 10, 11, 12, 14, 20, 21, 23, 24, 25, 31, 34, 35, 38, 41, 47, 51, 52, 62, 63, 64, 66, 67, 68, 69, 70, 71, 72, 73, 74, 76, 77, 80, 95, 103. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974), Sierra Alhamilla (Allorge & Casas, 1958), Sierra de los Filabres (Alcaraz *et al.*, 1982). Calcareous or siliceous rocks and epiphytic on the bases of *Quercus rotundifolia.*

**Grimmia pulvinata* var. *africana* 9. Rocks of acidic nature.

Grimmia trichophylla 1, 2, 3, 5, 11, 13, 21, 23, 41, 47, 52, 62, 63, 64, 66, 67, 68, 77, 80, 95. Gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990, *sub Grimmia* aff. *trichophylla* Grev.; Guerra *et al.*, 1992a, *sub Grimmia* aff. *trichophylla* Grev.). Acidic rocks.

Gigaspermum mouretii 100, 104, 108. Sierra del Cabo de Gata (Allorge & Casas, 1958; Casas, 1959; Casas, 1974; Acuña *et al.*, 1974; Casas, 1975; Casas *et al.*, 1981). Soils on stony slopes with *Chamaerops humilis.*

Funaria convexa 39, 84, 107, 108, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974, *sub F. calcarea* Wahlenb. subsp. *convexa* (Spruce) Husn.). Stony soils with herbaceous plants or very exposed, and banks at the bases of rocks.

Funaria hygrometrica 1, 6, 14, 15, 17, 52, 62, 78, 92, 95, 98, 100, 103, 104, 105, 106, 110. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974; Guerra & Gil, 1982), sierra Alhamilla (Allorge & Casas, 1958). Burnt, nitrified and altered soils, edges of paths, fields, etc.

Funaria muhlenbergii 47, 67, 91, 99, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub F. mediterranea* Lindb.; Allorge & Casas, 1958, *sub Funaria muhlenbergii* Hedw.; Acuña *et al.*, 1974, *sub F. calcarea* Wahlenb.; Acuña *et al.*, 1974, *sub F. calcarea* Wahlenb. var. *mediterranea* (Lindb.) C. Jens *et* Medel.; Guerra & Gil, 1982), Viator (Guerra & Gil, 1982), Venta de los Yesos (Ros & Guerra, 1987b). Shaded banks and hollows of rocks.

Funaria pulchella 22, 30, 33, 34, 35, 36, 38, 40, 41, 43, 45, 47, 48, 51, 52, 54, 60, 63, 64, 67, 71, 77, 79, 86, 95, 96, 98, 100, 103, 104, 106, 107, 108, 115. Gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Stony or sandy soils generally sheltered, protosoils and rocks with accumulated soil.

**Entosthodon attenuatus* 48, 50. Saline soils under *Sarcocornia fruticosa* (Cano & García-Zamora, 1995). Also on exposed soils and soils of sheltered slopes.

**Entosthodon fascicularis* 6. Seeping walls by roads.

Funariella curviseta 95, 103, 106, 112, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Funaria curviseta* (Schwaegr.) Milde; Allorge & Casas, 1958, *sub Funaria curviseta* (Schwaegr.) Milde; Acuña *et al.*, 1974, *sub Funaria curviseta* (Schwaegr.) Milde; Casas, 1974, *sub Funaria curviseta* (Schwaegr.) Milde). Stony slopes at the bases of *Chamaerops humilis*, protosoils in openings among bushes and rocks of acidic nature.

Goniomitrium seroi Sierra del Cabo de Gata (Casas, 1972; Casas, 1974; Acuña *et al.*, 1974; Casas, Brugués & Cros, 1981; Guerra & Ros, 1990). Fissures of acidic volcanic rocks (Casas, 1972).

Pyramidula algeriensis Sierra del Cabo de Gata (Casas & Simó, 1972; Acuña *et al.*, 1974; Casas, 1974; Casas *et al.*, 1981). Very stony soil.

Ephemerum recurvifolium Sierra del Cabo de Gata (Acuña *et al.*, 1974; Casas, 1974; Sérgio, 1982; Cano & García-Zamora, 1995), gypsiferous outcrop of Mojácar (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Calcareous soils on exposed, slightly wet slopes.

***Pohlia cruda* 3, 9, 10, 11, 12, 13, 14, 17, 18, 21, 26. Streambanks, shaded hollows at the bases of rocks and by running water.

**Pohlia melanodon* 12, 17, 37. Wet streambanks and sheltered soils in hollows of rocks.

***Pohlia nutans* 9. Streambanks.

**Pohlia proligera* 12, 17. Soils at the edges of streams and in cracks of slate with accumulated soil.

Pohlia wahlenbergii 14, 19, 38, 78. Barranco de la Mina (Abrucena) (Dia, 1991). Edges of river beds, occasionally submerged, and cracks with accumulated soil.

**Bryum alpinum* 3, 6, 9, 11, 15, 17, 30, 35. In seeping rocky walls and wet meadows, more or less humiferous in ravines.

Bryum argenteum var. *argenteum* 5, 6, 12, 13, 15, 16, 17, 18, 23, 25, 26, 27, 30, 34, 35, 37, 38, 39, 41, 42, 43, 55, 56, 65, 74, 76, 78, 82, 104. Sierra del Cabo de Gata (Acuña *et al.* 1974), sierra de los Filabres (Alcaraz *et al.*, 1992), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). On more or less nitrified soils and protosoils at the edges of paths and rocks with accumulated soil.

Bryum argenteum var. *lanatum* 38. Aguadulce (Allorge & Casas, 1958). Small openings of *Quercus rotundifolia* woods with *Riccia lamellosa, Riccia atromarginata* and *Crossidium crassinerve* (Allorge & Casas, 1958). Banks at the bases of rocks, more or less sheltered by herbaceous plants.

Bryum bicolor 1, 4, 7, 23, 29, 30, 33, 34, 35, 37, 40, 41, 43, 44, 45, 47, 50, 52, 56, 57, 59, 60, 61, 66, 69, 73, 74, 78, 82, 84, 90, 91, 93, 96, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974), Roquetas y Aguadulce (Allorge & Casas, 1958, *sub Bryum bicolor* var. *pseudoblindii* Amann.), several sites (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). On many types of soil.

**Bryum bornholmense* 17, 33, 54. Soils at the edges of streams and accumulated soil at the bases of rocks.

Bryum caespiticium 7, 9, 10, 12, 16, 17, 18, 26, 27, 33, 42, 54, 55, 67, 87, 89, 91, 99, 108, 111. Almería (Allorge & Allorge, 1946, *sub Bryum caespiticium* L.), gypsiferous outcrops of Mojácar and cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*,

1992a). Temporarily wet soils at the edges of streams and bare rocks or those with accumulated soil.

Bryum canariense Sierra del Cabo de Gata (Acuña *et al.*, 1974; Casas, 1974). Habitat not specified.

Bryum capillare 2, 8, 9, 10, 11, 12, 17, 29, 96, 101, 115. Punta del Sabinar (Guerra & Puche, 1984). Banks at the edges of streams, protosoils and sheltered rocks.

Bryum creberrimum Barranco de la Mina (Dia, 1991). On wet rocks.

**Bryum donianum* 63, 78, 99. Soils of slope, wet walls and accumulated soil in fissures of rocks.

Bryum dunense 1, 5, 6, 12, 15, 16, 17, 18, 25, 26, 27, 30, 32, 42, 49, 55, 65, 67, 70, 71, 72, 74, 77, 79, 82, 86, 89, 91, 95, 96, 97, 101, 103, 104, 106, 107, 108, 110. Punta del Sabinar (Guerra & Puche, 1984), gypsiferous outcrop of Venta de los Yesos (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a), sierra del Cabo de Gata (Hébrard & Pierrot, 1994). Protosoils, sandy and clayey soils. Fissures of very exposed rocks and rotting stumps of trees.

***Bryum elegans* 30. Fissures of rocks.

Bryum gemmilucens 1, 2, 30, 35, 36, 38, 40, 44, 52, 55, 66, 90, 95, 96, 100, 103, 106, 107, 114, 115. Cruce a Turrillas (Ros *et al.*, 1989), gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Banks sheltered by herbaceous plants, exposed soils in openings among bushes and nitrified protosoils.

**Bryum gemmiparum* 14, 22, 30, 78. Humiferous soils, accumulated soil at the bases of rocks, edges of river beds and leaking walls.

**Bryum klinggraeffii* 18, 34, 35, 38. Accumulated soil at the bases of rocks, nitrified rocks and protosoils.

***Bryum cf. pallescens* 17. Edges of river beds.

Bryum pseudotriquetum 3, 4, 7, 9, 11, 12, 14, 15, 17, 38, 78. Sierra de los Filabres (Alcaraz *et al.*, 1982). Seeping banks, edges of river beds, partly submerged, and rocks at the bottom of river beds.

Bryum radiculosum 34, 36, 41, 44, 47, 49, 53, 62, 79, 86, 88, 95, 100, 110, 111. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub B. murorum* (Schimp.) Berk.), several sites (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Rocks and banks with accumulated soil. Also on deep soils and protosoils.

Bryum ruderale 10, 52, 68, 103. Gypsiferous outcrops of Cuenca de Sorbas and Yesoncillo de Enmedio (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Exposed rocks and those more or less sheltered by herbaceous plants.

**Bryum subelegans* 12, 14, 103. More or less sandy banks and wet ground at the edges of streams.

Bryum torquescens 1, 2, 9, 11, 12, 13, 14, 15, 17, 20, 24, 25, 29, 31, 32, 34, 35, 36, 38, 41, 42, 45, 47, 48, 50, 51, 52, 59, 63, 66, 67, 69, 71, 74, 76, 77, 78, 83, 92, 95, 97,

100, 103, 104, 105, 106, 107, 108, 112, 113, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974, *sub B. capillare* subsp. *torquescens* (De Not.) Kindb.), punta del Sabinar (Guerra & Puche, 1984), gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Mainly humiferous soils, although it can be found in all kinds of soils: sandy, saline, loamy-gypsiferous, etc.

Rhizomnium punctatum 9, 11, 12, 17. Sierra de los Filabres (Alcaraz *et al.*, 1982). Streambanks and hollows of rocks, normally shaded by herbaceous plants.

***Plagiomnium ellipticum* 9. Wet banks at the edges of river beds.

**Plagiomnium undulatum* 3. Seeping banks on acidic soils.

**Aulacomnium androgynum* 11. Shaded accumulated soil on rocks at the edges of streams.

Bartramia ithyphylla 17, 21. Adra (Casares-Gil, 1915, *sub Bartramia ithyphylla* (Haller) Brid.). Banks at the bases and bottoms of hollows in rocks.

**Bartramia pomiformis* 3, 9, 17. Banks at the edges of streams and protosoils among rocks.

Bartramia stricta 23, 38, 64, 77, 95, 96, 100, 103. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974). Banks and fissures of basaltic rocks with accumulated soil.

Anacolia menziesii 64. Ledges of rocks with accumulated soil, lightly sheltered. It has been recently reported as new for the European continent by García-Zamora, Ros, Cano & Guerra (in press).

**Philonotis cf. arnellii* 11. Very humiferous soil, temporarily wetted by melt-water.

***Philonotis caespitosa* 9. Waterlogged soil.

Philonotis calcarea Barranco de la Mina (Dia, 1991, *sub Philonotis cf. calcarea*), Sierra de los Filabres (Cano & García-Zamora, 1995). Schistose banks wet with meltwater. The reference by Cano & García-Zamora (1995) is incorrect, this proved to be *Philonotis fontana* (Hedw.) Brid.

Philonotis fontana var. *fontana* 9, 14, 17, 28. Sierra de los Filabres (Ros *et al.*, 1989; Cano & García-Zamora, 1995, *sub Philonotis calcarea* (B. & S.) Schimp.). Ledges of rocks with accumulated soil at the edges of streams.

****Philonotis fontana* var. *pumila* 9. Sierra de los Filabres (Cano & García-Zamora, 1995, *sub P. tomentella* Mol.). Very wet schistose, humiferous soils shaded by herbaceous plants.

***Amphidium mougeotii* 9, 11, 12, 17. Edges of streams, accumulated soil on rocks.

**Orthotrichum acuminatum* 69, 75, 76. Epiphytic at the bases of *Quercus rotundifolia* or on exposed roots.

Orthotrichum affine 12. Sierra de Alhamilla (Alcaraz *et al.*, 1982). On the bases of *Quercus rotundifolia.*

Orthotrichum anomalum 9, 11, 15, 19, 21. Sierra de los Filabres (Alcaraz *et al.*, 1982). Siliceous rocks, from vertical to supravertical.

**Orthotrichum cupulatum* 62. On bare acidic rocks.

Orthotrichum diaphanum 12, 14, 69, 73, 75, 76, 80. Sierra Alhamilla (Alcaraz *et al.*, 1982). Epiphytic on trunk or roots of *Quercus rotundifolia* and *Populus nigra.*

***Orthotrichum ibericum* 75. Epiphytic on bases of *Quercus rotundifolia,* mixed with other *Orthotrichum* species from 1150–1300 m.

**Orthotrichum lyellii* 9, 75, 76. Epiphytic on trunks or roots of *Quercus rotundifolia.* Also on rocks of varied nature.

**Orthotrichum macrocephalum* 12, 73, 80. Epiphytic on trunk of *Quercus rotundifolia.*

**Orthotrichum pallens* 12. On trunk of *Quercus rotundifolia.*

**Orthotrichum pumilum* 12, 14, 75, 76, 80. On trunks or roots of *Quercus rotundifolia* and *Populus nigra.*

**Orthotrichum rupestre* 3, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 26, 31, 38, 64, 69, 77. Epiphytic on trunks of *Quercus rotundifolia* and *Populus nigra.* Also on exposed acidic rocks, rocky ledges and streambanks.

**Orthotrichum striatum* 69, 75. Epiphytic on trunks of *Quercus rotundifolia.*

**Orthotrichum tenellum* 12, 69, 76. On trunks or roots of *Quercus rotundifolia.*

Orthotrichum tortidontium 75. Epiphytic on trunk of *Quercus rotundifolia,* up to 2 m high. Species recently described by Lara, Garilleti & Mazimpaka (1996) from Morocco and Spain. The sample from Almería was included in that work but at lower altitude than in Morocco. Its ecology suggests a wider distribution in the Mediterranean mountains.

***Orthotrichum urnigerum* 62. On bare acidic rocks.

***Hedwigia stellata* 9, 21, 38. Exposed siliceous rocks. This species has been confused with *Hedwigia ciliata* until recently and it is possible that many of the references refer to *H. stellata.* Hedenäs (1994) has revised some material from Europe, North America and Asia, and Casas & Sérgio (1996) have studied material from the Iberian Peninsula, Tenerife and Madeira.

Fontinalis antipyretica Sierra de los Filabres (Alcaraz *et al.*, 1982). Submerged in streams of very pure water, calcareous or not.

Leucodon sciuroides var. *sciuroides.* 9, 21, 52, 80. It occurs on rocks sometimes with accumulated soil.

Leucodon sciuroides var. *morensis* Sierra de los Filabres (Alcaraz *et al.*, 1982). Earthy accumulations on rocks of diverse nature (limes, schists, basalts, etc.).

**Antitrichia californica* 11, 21, 80. Exposed rocks of acidic nature.

**Pterogonium gracile* 31, 52, 64. Bare acidic rocks, or with accumulated soil.

**Leptodon smithii* 52, 80. Rocks of basic nature and deposits of soil on rocks of caves.

Fabronia pusilla 80. Sierra de los Filabres (Cano & García-Zamora, 1995). Deposits of soil in poorly illuminated caves.

**Pterigynandrum filiforme* 11, 21. Rocks of acidic nature and banks at the bases of rocks.

Palustriella commutata 4. Barranco de la Mina (Dia, 1991). Edges of river beds partly submerged.

Calliergonella cuspidata 3, 17, 28. Sierra de los Filabres (Alcaraz *et al.*, 1982; Ros *et al.*, 1989). Banks at the edges of streams, more or less sheltered by herbaceous plants.

Scorpiurium circinatum 3, 9, 11, 17, 18, 24, 26, 47, 48, 51, 52, 63, 86, 95, 103, 108, 112. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Acuña *et al.*, 1974). Rocks and deep hollows in them.

Homalothecium aureum 2, 4, 7, 9, 15, 17, 23, 24, 25, 31, 32, 34, 35, 38, 41, 51, 52, 63, 64, 67, 68, 69, 71, 73, 74, 75, 77, 96, 99, 103. Adra (Casares-Gil, 1915, *sub Camptothecium aureum* (Lag.) Br. Eur.), Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub Camptothecium aureum* (Lag.) Br. Eur.; Acuña *et al.*, 1974, *sub Camptothecium aureum* (Lag.) B.S.G.), gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). More or less humiferous soils at the bases of rocks.

**Homalothecium lutescens* 9, 21. Banks at the bases of rocks with very humiferous soils.

***Homalothecium philippeanum* 17. Soils at the edges of streams.

Homalothecium sericeum 9, 10, 11, 17, 21, 24, 26, 32, 52, 64, 67, 76, 77, 80, 86. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974). Accumulated soil in fissures, deep hollows of rocks and wet meadows.

**Brachythecium albicans* 9, 11, 12, 32, 63, 101. Rocky walls, sometimes with accumulated soil.

***Brachythecium dieckii* 2, 7, 13, 21, 23, 68, 76. Banks and rocky exposed slopes. It is only known in the central mountains of Spain and the Canary Islands. This species has been confused with *Brachythecium velutinum* and it is possible that it appears in other geographical areas (Hedenäs, 1993).

**Brachythecium rivulare* 9, 11, 12, 14, 17, 21. Barranco de la Mina (Dia, 1991, *sub Brachythecium cf. rivulare* Bruch & al.). Accumulated soil at the bases of rocks more or less submerged.

***Brachythecium salebrosum* 11, 14, 17, 67, 86, 115. Rocky banks and sandy soil at the edges of river beds, sheltered by bushes.

**Brachythecium velutinum* 2, 3, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 24, 25, 32, 38, 41, 47, 52, 68, 69, 70, 76. Soils and banks, more or less humiferous and wet. Also on rocks and bases of *Quercus rotundifolia.*

Scleropodium touretii 2, 7, 12, 14, 31, 32, 38, 41, 67, 71, 77, 95, 99, 103. Sierra del Cabo de Gata (Allorge & Allorge, 1946, *sub S. illecebrum* (Vaill., Schwaegr.) Br. Eur.; Acuña *et al.*, 1974). Rocky, very humiferous banks and bases of rocks.

Rhynchostegium megapolitanum 3, 15, 24, 29, 32, 41, 47, 50, 52, 58, 62, 63, 67, 91, 94, 95, 96, 99, 103, 104, 107, 108, 112, 115. Sierra del Cabo de Gata (Allorge &

Allorge; Acuña *et al.*, 1974), gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). More or less humiferous and rocky soils, artificial walls and rocks of diverse nature.

Rhynchostegium riparioides 9, 11, 12, 14, 17, 38. Barranco de la Mina (Dia, 1991). Walls on which water drips and banks and rocks at the edges of streams.

**Eurhynchium hians* 3, 4, 17, 26, 48. Edges of streams, even partly submerged, fountains and banks on which water drips. Also in hollows at the bases of rocks.

**Eurhynchium meridionale* 52. Fissures of rocks with accumulated soil.

**Eurhynchium praelongum* 13. Banks shaded by herbaceous plants. It has been quoted wrongly by Allorge & Allorge (1946) from Almería, because the site given by them (Sierra Espuña) belongs to Murcia province.

**Eurhynchium pulchellum* 11, 23, 38, 67, 68. Banks at the bases of rocks, sometimes at the edges of streams.

**Euhrynchium speciosum* 17. Ledge of rock in cave well shaded by vegetation.

**Rhynchostegiella tenella* 48, 52. Protosoils on basic rocks.

**Plagiothecium nemorale* 9, 17, 21. Hollows of poorly illuminated rocks and bottoms of fissures of metamorphic rocks without soil.

Plagiothecium succulentum 11. Sierra de los Filabres (Cano & García-Zamora, 1995). Fissures of metamorphic rocks without soil. The reference published by Cano & García-Zamora (1995) corresponds to *Plagiothecium nemorale* (Mitt.) Jaeg.; nevertheless, the presence of this species in Almería has been confirmed by Dr. L. Hedenäs from another site in Sierra de los Filabres.

Hypnum cupressiforme var. *cupressiforme* 21. Gypsiferous outcrop of Cuenca de Sorbas (Martínez-Sánchez, 1990; Guerra *et al.*, 1992a). Banks at the bases of rocks.

****Hypnum cupressiforme* var. *julaceum* 21. Base of acidic rocks.

**Hypnum cupressiforme* var. *lacunosum* 9, 64. Acidic rocks, sometimes with accumulated soil and hardly shaded.

Hypnum jutlandicum Sierra de los Filabres (Alcaraz *et al.*, 1982). On metamorphic siliceous rocks.

***Hypnum revolutum* 9. On rocks of acidic nature.

LIVERWORTS

***Sphaerocarpos michelii* 95, 99, 115. Stony slopes at the bases of *Chamaerops humilis* or other bushes.

***Sphaerocarpos texanus* 98. Stony soil among herbaceous plants.

Targionia hypophylla 2, 7, 15, 17, 23, 24, 30, 31, 32, 34, 35, 36, 37, 38, 40, 41, 43, 44, 45, 47, 48, 50, 60, 61, 62, 63, 64, 67, 68, 71, 77, 86, 94, 95, 98, 99, 100, 101, 103,

104, 106, 107, 108, 112, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Allorge & Casas, 1958; Allorge & Casas, 1958, *sub T. lorbeeriana* K.M.; Acuña *et al.*, 1974; Acuña *et al.*, 1974, *sub T. lorbeeriana* K. Müll.; Casas, 1974, *sub T. lorbeeriana* K. Müll.; García-Zamora *et al.*, 1990), Sorbas (García-Zamora *et al.*, 1990), Rodalquilar (García-Zamora *et al.*, 1990, *sub T. lorbeeriana*), several sites (Jovet & Bischler, 1976), gypsiferous outcrop of cuenca de Sorbas (Martínez-Sánchez, 1990). Fissures of rock with accumulated soil and protected banks. Following García-Zamora *et al.* (1990) we have considered *Targionia lorbeeriana* as a synonym of *T. hypophylla.*

Plagiochasma rupestre 47. Almería (Allorge & Allorge, 1946), Aguadulce (Allorge & Casas, 1958; Jovet & Bischler, 1976), near venta de los Castaños and near Enix (Jovet & Bischler, 1976). Banks in hollows of rocks.

Reboulia hemisphaerica 2, 3, 9, 10, 11, 15, 17, 34, 37, 38, 41, 44, 67, 68, 71, 77. Several sites (Jovet & Bischler, 1976). Fissures and hollows of rocks with accumulated soil and protected banks.

Mannia androgyna 22, 29, 30, 35, 38, 40. Sierra del Cabo de Gata (Allorge & Casas, 1958, *sub Grimaldia dichotoma* Raddi; Acuña *et al.*, 1974, *sub G. dichotoma* Raddi; Ros & Guerra, 1987b). Humiferous soils shaded by herbaceous plants and at bases of siliceous rocks.

Lunularia cruciata 7, 9, 29, 32, 47, 48, 67. Sierra del Cabo de Gata (Acuña *et al.*, 1974), near Alhama de Almería and río Andarax (Jovet & Bischler, 1976). Banks near streams, hollows of rocks and protosoils on rocks.

Athalamia spathysii 47, 95, 103, 108. Sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub Clevea spathysii* (Lindb.) K. Muel.; Casas, 1974, *sub Clevea spathysii* (Lindb.) K. Müll.), near Níjar (Jovet & Bischler, 1976, *sub Clevea spathysii* (Lindenbg.) Mueller). Shaded banks, stony and sandy soils.

Preissia quadrata 7, 9, 17. Barranco de la Mina (Dia, 1991). Soil accumulated at the bases of artificial walls or rocks, sometimes at the edges of streams.

**Marchantia polymorpha* 11. Barranco de la Mina (Dia, 1991, *sub Marchantia cf. polymorpha* L.). Accumulated soil on very shaded rocks and at the edges of streams. *Oxymitra incrassata* Sierra del Cabo de Gata and castillo de Almería (Allorge & Allorge, 1946, *sub Oxymitra pyramidata* Dum.; Acuña *et al.*, 1974, *sub O. pyramidata* Dum.), cabo de Gata (Ros & Guerra, 1987b). Acidic to neutral soils and irrigated volcanic rocks (andesites).

Riccia atromarginata Several sites (Allorge & Casas, 1958; Jovet & Bischler, 1976; Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990). Exposed generally deep dry soils, sometimes lightly nitrified, and gaps of pastures developed on gypsiferous outcrops.

***Riccia beyrichiana* 17, 30. Soils at the edges of streams and accumulated soil at the bases of rocks.

***Riccia bifurca* 9. Hollows of schistose rocks and humiferous banks.

**Riccia cavernosa* 110. Saline soil among herbaceous plants.

Riccia crustata Venta de los Yesos (Casas, 1973; Ros & Guerra, 1985), Almería (Casas *et al.*, 1981), several gypsiferous outcrops (Martínez-Sánchez, 1990). Small wet depressions of saline and gypsiferous soils.

**Riccia gougetiana* var. *gougetiana* 9, 30, 107. Stony soils and soil accumulated among rocks.

Riccia gougetiana var. *armatissima* 9, 17, 26, 30, 94, 95, 96, 98, 99, 100, 101, 103, 104, 107, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946, sub *R. erinacea* Schffn. and *R. gougetiana* Durieu & Mont. var. *erinacea* Schiffn.; Allorge & Casas, 1958, *sub R. gougetiana* Mt. var. *erinacea* Schffn.; Acuña *et al.*, 1974, *sub R. gougetiana* var. *erinacea* Schffn.; Casas, 1974, *sub R. gougetiana* Mt. var. *erinacea* Schiffn.; Ros & Guerra, 1987b), Roquetas (Allorge & Casas, 1958, *sub R. gougetiana* Mt. var. *erinacea* Schffn.). More or less humiferous and sheltered wet meadows, protosoils among rocks and sandy soils.

Riccia lamellosa 30, 47, 48, 61, 84, 86, 101, 103, 107, 108. Almería (Allorge & Allorge, 1946), Roquetas (Allorge & Casas, 1958), sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974), several sites (Jovet & Bischler, 1976; Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990). Sandy soils sometimes in openings among bushes and protosoils among rocks.

**Riccia michelii* 9, 44. Bare soils in openings among bushes and wet meadows, more or less humiferous.

Riccia nigrella 100, 104, 106, 108, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974; Jovet & Bischler, 1976; Ros & Guerra, 1987b). Loose acidic or neutral soils and irrigated volcanic rocks (andesites) enriched with calcium carbonate.

Riccia sommieri Sierra de los Filabres (Cano & García-Zamora, 1995). Banks at the bases of schistose rocks more or less shaded by herbaceous plants.

Riccia sorocarpa 31, 33, 35, 36, 43, 52, 67, 68, 77, 94, 95, 96, 98, 99, 100, 101, 104, 106, 107, 108, 114, 115. Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974; Jovet & Bischler, 1976; Ros & Guerra, 1987b), Roquetas (Allorge & Casas, 1958), near Enix (Jovet & Bischler, 1976), sierra Alhamilla (Ros & Guerra, 1987), gypsiferous outcrops of Cuenca de Sorbas and Cuevas de los Medinas (Martínez-Sánchez, 1990). On clayey soils at the bases of basaltic rocks (Allorge & Allorge, 1946). Soil accumulated at the bases of rocks, protosoils and sandy soils.

Riccia trabutiana Aguadulce (Allorge & Casas, 1958, *sub R. atromarginata* Lev. var. *glabra* Lev.), sierra del Cabo de Gata (Acuña *et al.*, 1974, *sub R. atromarginata* Lev. var. *glabra* Lev.), near Venta de los Castaños and near Enix (Jovet & Bischler, 1976). Small lawns on soils of varied nature, humiferous or not.

***Riccia warnstorfii* 17. Accumulated soil among rocks shaded by herbaceous plants.

Metzgeria furcata Sierra de los Filabres (Cano & García-Zamora, 1995). Shaded walls of metamorphic rocks.

**Pellia endiviifolia* 3, 9, 12, 17. Accumulated soil at the bases or in hollows of rocks and seeping banks at the edges of streams.

Fossombronia caespitiformis var. *caespitiformis* 9, 44, 46, 47, 48, 49, 50, 51, 52, 59, 86, 87, 95, 98, 99, 100, 101, 103, 104, 107, 108, 115. Sierra del Cabo de Gata (Allorge & Casas, 1958; Acuña *et al.*, 1974), several sites (Jovet & Bischler, 1976), among Lucainena de las Torres and Sorbas (Ros & Guerra, 1987b), several gypsiferous outcrops (Martínez-Sánchez, 1990). Limy or loamy-gypsiferous soils and banks.

Fossombronia caespitiformis var. *subcristata* Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974). Temporarily wet soils at the bases of basaltic rocks.

Fossombronia echinata 9. Aguadulce (Jovet & Bischler, 1976). Hollows at the bases of rocks, shaded and sheltered.

Fossombronia wondraczekii Sierra del Cabo de Gata (Allorge & Allorge, 1946; Acuña *et al.*, 1974), gypsiferous outcrop of Mojácar (Martínez-Sánchez, 1990, *sub F. mittenii* Tindall.; Martínez-Sánchez *et al.*, 1991, *sub F. mittenii* Tindall.). Clayey soil at the bases of basaltic rocks, with *Riccia sorocarpa* (Allorge & Allorge, 1946).

***Lophozia incisa* 9. Banks at the bases of rocks next to river beds.

Southbya nigrella 34, 44, 45, 46, 50, 51, 95. Sierra del Cabo de Gata (Acuña *et al.*, 1974), Viator (Guerra & Gil, 1982), several sites (Jovet & Bischler, 1976), several gypsiferous outcrops (Martínez-Sánchez, 1990). Wet rocky banks in open but not sunny places where moisture is retained for a long time.

Southbya tophacea 48. Sierra del Cabo de Gata (Guerra & Gil, 1982). Protosoils or thin layers of soil accumulated on rocks.

**Gongylanthus ericetorum* 99, 100. More or less stony soils and exposed wet soils.

***Plagiochila porelloides* 11, 17. Banks near streams, sometimes submerged.

***Lophocolea minor* 17. Bases of rocks with soil and ledges on shaded rocks.

Chiloscyphus polyanthos 3, 9, 11, 12, 17. Sierra de los Filabres (Ros & Guerra, 1985). Banks at the edges of streams and rocks at the bottoms of river beds.

***Scapania praetervisa* 17. Very wet soils at the edges of streams and in hollows of rocks.

Cephaloziella baumgartneri 34, 44, 47, 48, 51, 86. Sierra del Cabo de Gata (Acuña *et al.*, 1974; Guerra & Gil, 1982), several sites (Jovet & Bischler, 1976), Viator (Guerra & Gil, 1982), several gypsiferous outcrops (Martínez-Sánchez, 1990). Humiferous soils at the base of rocks, shaded by herbaceous plants, bare soils in openings among bushes and protosoils or thin layers of soil accumulated among rocks.

***Cephaloziella cf. hampeana* 9. Soils at the bases of rocks next to river beds.

***Cephaloziella stellulifera* 31. Banks under *Quercus rotundifolia.*

**Porella platyphylla* 9, 11, 17, 21, 52. Sierra de los Filabres (Alcaraz *et al.*, 1982, *sub Madotheca rivularis* (Hartm.) Nees.). Rocks and shaded walls.

Frullania dilatata 96, 103. Sierra del Cabo de Gata (Acuña *et al.*, 1974). Fissures of rocks and accumulated soil in the hollows of sheltered rocks.

Species excluded from the catalogue

Philonotis tomentella Cited by Cano & García-Zamora, 1995. The plant is *P. fontana* var. *pumila.*

Riccia glauca Cited by Cano & García-Zamora, 1995. This is *R. bifurca.*

Porella cordaeana Cited by Alcaraz *et al.* (1982). It has proved to be *P. platyphylla.*

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P. García-Zamora, R. M. Ros and J. Guerra, Departamento de Biología Vegetal (Botánica), Facultad de Biología, Universidad de Murcia, E-30100 Murcia, Spain. E-mail: rmros@fcu.um.es

Appendix 1. Details of the study sites

A. Sierra de los filabres

1. Cerro del Mojón (Macael). WG6226. 1060 m.
2. Near Los Polillos (Tahal). WG6125. 1100 m.
3. Barranco de la Golapra (Gérgal). WG3922. 1600 m.
4. Near La Fuentecilla (Bacares). WG4223. 1800 m.
5. Peak Tetica (Bacares). WG5223. 2080 m.
6. Next to Casa del Sastre (Velefique). WG5323. 1700 m.
7. Barranco del Fragüero. (Tahal). WG6223. 1100 m.
8. Fuente de los Borregos (Gérgal). WG3822. 1700 m.
9. Barranco del Negro (Gérgal). WG3922. 1650 m.
10. Los Morcillas (Bacares). WG4022. 1700 m.
11. Barranco del Maguillo (Bacares). WG4122. 1700 m.
12. Barranco de Julián (Bacares). WG4422. 1650 m.
13. Alto de García (Bacares). WG5022. 1800 m.
14. Arroyo de los Pastores (Gérgal). WG3321. 1750 m.
15. Barranco de Cano (Gérgal). WG3721. 1700 m.
16. Near Calar Alto (Gérgal). WG3920. 2000 m.
17. Barranco del Pino (Bacares). WG4221. 1850 m.
18. Barranco de Juan Pérez (Bacares). WG4421. 1750 m.
19. Arroyo Muñoz (Gérgal). WG3520. 1850 m.
20. Barranco del Caño (Tahal). WG6220. 1100 m.
21. Barranco Berruga (Gérgal). WG3619. 1800 m.
22. Near Casa Pasaica. Barranco del Lugar (Velefique). WG5119. 1700 m.
23. Road from Cantoria to Uleila del Campo, km 30, C-3325 (Benizalón). WG7019. 1100 m.
24. Road from Cantoria to Uleila del Campo, km 31, C-3325 (Benizalón). WG7119. 1000 m.
25. Road from Cantoria to Uleila del campo, km 33, C-3325 (Benizalón). WG7219. 1000 m.
26. Piedras del Deseo (Gérgal). WG3118. 2000 m.
27. La Piedra del Sombrerillo (Gérgal). WG3318. 1900 m.
28. Barranco de La Pileta (Gérgal). WG3417. 1600 m.
29. Barranco del Lugar (Velefique). WG5218. 1400 m.
30. Barranco de Sufli (Senés). WG5818. 1100 m.
31. Near Las Zorreras (Tahal). WG6318. 1200 m.
32. Road from Cantoria to Uleila del Campo, km 31, C-3325 (Benizalón). WG7118. 1050 m.
33. Road from Cantoria to Uleila del Campo, km 32, C-3325 (Benizalón). WG7218. 950 m.
34. Near venta La Huertecica (Lubrín). WG8118. 600 m.
35. Alto de Molina. Road from Senés to Tabernas, km 2 (Senés). WG5917. 1000 m.
36. Rambla del Moratón. Road from Senés to Tabernas (Senés). WG6117. 1000 m.
37. Road from Uleila del Campo to Monteagudo, km 38, C-3325 (Uleila del Campo). WG7117. 800 m.
38. Loma del Torilillo (Olula de Castro). WG4616. 1350 m.
39. Rambla de la Hoya Pardo (Velefique). WG5214. 800 m.
40. Barranco Raspajos. Road from Tallón Alto to Gérgal, km 8 (Gérgal). WG4511. 1050 m.
41. Cerro Santiago. Road from Tallón Alto to Gérgal, km 5 (Olula de Castro). WG4511. 1050 m.
42. Barranco de Los Segundos (Castro de Filabres). WG5011. 750 m.
43. Road from Senés to Tabernas, km 10 (Benizalón). WG5810. 600 m.

B. Sierra Cabrera

44. Near Cortijo Colorado (Turre). WG9510. 180 m.
45. Rambla del Pocico (Turre). WG9610. 170 m.
46. Next to Cortijo Grande (Turre). WG9409. 180 m.
47. Loma del Colorado (Turre). WG9408. 400 m.
48. Cortijo Tremecén (Turre). WG9506. 650 m.
49. Road from Sorbas to Río de Aguas, km 4 (Sorbas). WG8105. 400 m.
50. Caserío El Puerto (Turre). WG9105. 420 m.
51. Caserío El Prado (Turre). WG9004. 550 m.
52. Peak Mezquita (Turre). WG9304. 850 m.
53. Rambla de Mizala (Sorbas). WG8401. 310 m.
54. Barranco Malco (Carboneras). WF9999. 70 m.
55. Cañada Blanco (Sorbas). WF8597. 240 m.

C. Sierra Alhamilla

56. Road to Turrillas, 3 km to N-340 (Tabernas). WG6202. 550 m.
57. Road N-340, km 157 (Tabernas). WG6602. 600 m.
58. Los Encalmados (Turrillas). WF6799. 750 m.
59. Rambla de La Higuerilla (Lucainena de las Torres). WF6899. 700 m.
60. Near cortijo La Cerradilla (Lucainena de las Torres). WF7299. 500 m.
61. Hoya Segura (Tabernas). WF5496. 700 m.
62. Los Manueles (Turrillas). WF6496. 1100 m.
63. Barranco de la Cueva (Lucainena de las Torres). WF7396. 600 m.
64. Rambla de la Sierra (Tabernas). WF6095. 1100 m.
65. Barranco del Castro (Almería). WF6195. 1350 m.
66. Las Palomas (Tabernas). WF6295. 1200 m.
67. Next to El Puntal 1 (Tabernas). WF5194. 600 m.
68. Next to El Puntal 2 (Tabernas). WF5294. 800 m.
69. Next to El Puntal 3 (Tabernas). WF5394. 900 m.
70. Las Tejoneras (Tabernas). WF5694. 1100 m.
71. Peak Sierra Alhamilla (Almería). WF5794. 1300 m.
72. Near Piedras de Aldana (Tabernas). WF5894. 1200 m.
73. Barranco de La Puerca. WF5994. 1200 m.
74. Barranco del Castro (Almería). WF6194. 1200 m.
75. Near peak Colativí (Almería). WF6294. 1340 m.
76. Loma Blanca (Turrillas). WF6394. 1000 m.
77. Next to barranco de La Puerca (Almería). WF5993. 1100 m.
78. Cortijo Frasquito (Níjar). WF6593. 800 m.
79. Next to cortijada de San Ignacio (Níjar). WF7393. 410 m.
80. Barranco del Monegue (Pechina). WF5692. 1200 m.
81. Rambla Espinaza (Pechina). WF5390. 400 m.
82. Rambla Palmilla (Rioja). WF5189. 270 m.
83. Barranco de Benítez (Pechina). WF5087. 180 m.

D. Sierra del Cabo de Gata

84. Near cortijada de El Molino de la Balsa Blanca (Níjar). WF8588. 180 m.
85. Cerro de la Mata Lobera (Níjar). WF9188. 90 m.
86. Base of the peak Jayón (Níjar). WF8587. 370 m.
87. Near cortijada de los Garrillos. La Serrata (Níjar). WF8286. 190 m.
88. Next to cortijada Balsa Seca (Níjar). WF7384. 100 m.
89. Hill of the peak Artichuela (Níjar). WF8582. 160 m.
90. Las Yeseras (Níjar). WF7480. 200 m.
91. Near cortijo de los Tollos (Níjar). WF8780. 80 m.
92. Near Boca de los Frailes (Níjar). WF7973. 100 m.

93. Cortijo Peralta (Níjar). WF8273. 50 m.
94. Next to cortijo de la Velasca (Níjar). WF7572. 280 m.
95. Rambla de las Higueras (Níjar). WF7672. 200 m.
96. Peak Carneros (Níjar). WF7671. 250 m.
97. Cerro de los Frailes (Níjar). WF8271. 400 m.
98. Near cortijada de El Pozo del Cabo (Almería). WF7070. 10 m.
99. Near cortijo de Doña Angeles (Níjar). WF7870. 40 m.
100. Rambla de El Pozo de los Frailes (Níjar). WF7970. 10 m.
101. El Sabinar, peak Rellana (Almería). WF7169. 100 m.
102. Near cortijo Palmera (Almería). WF7068. 20 m.
103. Near cortijos del Barranco (Níjar). WF7468. 180 m.
104. Way from cortijada del Romeral to cortijo del Mónsul (Níjar). WF7668. 120 m.
105. Cortijada del Romeral (Níjar). WF7768. 50 m.
106. Barranco Pollatos (Níjar). WF7567. 100 m.
107. Next to cortijo del Mónsul (Níjar). WF7667. 100 m.
108. Barranco del Mónsul. (Níjar). WF7566. 50 m.
109. Campillo del Genovés (Níjar). WF7766. 0 m.
110. Beach of Genoveses (Níjar). WF7866. 0 m.
111. Near casas El Corralete (Almería). WF7165. 100 m.
112. Peak San Francisco (Níjar). WF7265. 100 m.
113. Barranco del Negro (Níjar). WF7365. 150 m.
114. Barranco del Mónsul (Níjar). WF7565. 100 m.
115. Lighthouse of Cabo de Gata (Níjar). WF7264. 30 m.